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MAINTENANCE EXPERIENCE AND DEVELOPMENT
ON THE "CALIFORNIA" SCALER

by

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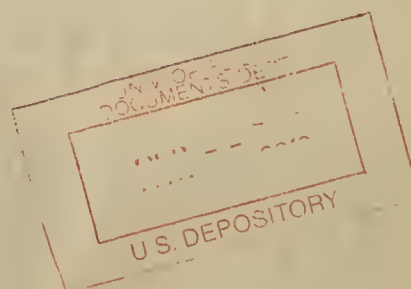
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MAINTENANCE EXPERIENCE AND DEVELOPMENT ON THE "CALIFORNIA" SCALER

By W. T. E. Elmendorf

INTRODUCTION

The writer has been working with S. G. English's group in building 706-A since November 29, 1943, and has been maintaining the California Circuits in the counting room of building 205 since that time. This report is designed to give a general discussion of the operation of the operation of the California Circuits, and report on some experimental work that the writer and members of Mr. English's group have carried on. Maintenance data is for the period from 11/29/43 to 1/15/44.

CIRCUITS IN USE

The California circuits in Building 205 are composed of three type A Beta circuits (see drawing 717-B-12) using Neher-Harper quenching for mica window G-M tubes and five type B Alpha circuits (Dwg. 717-B-13) with type A amplifiers (Dwg. 717-B-14). There are three magnetic type alpha chambers and two standard alpha chambers used with the five alpha sets.

Each circuit is checked with a standard every shift and adjustment made if necessary. All adjustments are entered in the set log book and these complete records are available for inspection.

DETAILED DESCRIPTION

A. BETA INPUT CIRCUIT (717-B-12)

This circuit consists of an external Neher-Harper quench tube (6J7G), a 6SJ7 amplifier, and a 605 inverter amplifier. No maintenance of any kind has been performed on this circuit since 11/29/43 except for replacing G-M tubes, four of which lost their plateau and two of which had their windows broken.

Experimental attempts to build the Neher-Harper tube into the set have failed to date as the pulses obtained without modification of the input amplifier would not trip the scaler. Work on this phase will be continued.

Examination of the relative plateaus of an Eck Krebs G-M tube with resistance and Neher-Harper quenching was made. The results obtained are included in Table 1 and show that the plateau was lengthened by a factor of between 2 and 3 by use of Neher-Harper quenching.

The difference in counts per minute shown in the table was due largely to different geometry of the source. However, the writer understands that the resolution of the Neher-Harper circuit is slightly less than that of a resistance quenched circuit.

The circuit used in the Type A Scaler (717-B-12) is unsuitable for use with resistance quenching without a preamplifier. A circuit consisting of two amplifier tubes is required to give a pulse of the proper sign, large enough to trip the scaler. This difficulty was overcome in the experimental Beta Set (717-B-11) by using an input circuit very similar to the Chicago Type, replacing the second 6C5 with a 6SJ7.

B. ALPHA CHAMBERS (Dwg. 717-B-14)

The electronic circuits of the magnet and standard alpha chambers are the same. Batteries supply all voltages used.

Operating experience with these chambers has been rather unsatisfactory. It has been necessary to replace the 38 tube at frequent intervals. The criterion for replacement of the tube is high hash level or low counting rate on the standard sample.

C. ALPHA AMPLIFIER (Dwg. 717-B-14)

This amplifier is a three tube non-linear non-fed back amplifier using a D. C. filament supply for the first tube. The first and last tube are zero bias tubes and the gain control is normally set so that the alpha pulses saturate the last tube.

As would be expected from the design, the amplifier is extremely critical as to the tubes, the first 6J7 being the most critical. However, when tubes have been selected, little operating trouble has been experienced. Only one 6J7 has been replaced in 205 building since December 1.

The gain plateau is usually quite long, varying from the point where the alpha pulses first saturate, to the point where the hash counts. The very good signal to noise ratio enables alphas to be counted over 5×10^6 betas in a standard chamber, and over 10^9 betas at 8% geometry with a magnet chamber.

The feature of saturating the output tube enables the control chemists to judge very well as to whether a sample can be counted. The gain can be reduced only so far as will still give saturated pulses and, if the hash is near the tripping height then, the sample cannot be counted reliably. This enables an inexperienced operator to judge when he is getting near the danger point, as the picture is very clear on the oscillograph.

Critical circuit constants in this circuit are the input condenser and the screen dropping resistors.

D. HUNTOON STROHMEYER PULSE SHARPENER (717-B-13)

This is a multivibrator circuit which serves to provide sharp, even height pulses to the scaler. Operating difficulties have been confined to defective 6B8 tubes, two tubes having been replaced since December 1. A tube tester will not give a reliable indication as to whether a tube is good for this service.

E. TRIODE SCALING STAGES (Dwg. 717-B-11, 12, and 13)

The triode scaling stages consist of a 6C5 interstage amplifier biased beyond cutoff and two 6C5 tubes with their grids cross coupled to the plates of the opposite tube. This circuit has proven to be very reliable and easy to service, only five service calls due to failure to the scaling stages being encountered between November 29, 1943 and January 13, 1944. Two of these were due to bad mica condensers (bad on a condenser tester), one due to an open reset switch, one due to a shorted 6C5, and one due to defective 400,000 ohm resistors in the scaling stages. Since January 13, two failures have been encountered, both due to defective rectifier tubes. The characteristic of this failure is the same as that due to low B+, i.e. the interstage amplifiers fail to pass the pulse. On one set, it was found that the set constants were such that the B+ with good rectifier tubes was barely high enough.

The voltages on 12 operating sets were taken on January 12 with the following results:

Range of B+ voltage 330 - 390 volts.

Range of interstage amplifier B- voltage -35 to -40 volts.

Range of scaling pair grid return voltage -69 to -78 volts.

Range of conducting plate voltages 50 to 180 volts.

Range of grid voltage -5.3 to 17. *

Maximum grid difference. Regular set 9.4 volts. *

* Grid voltages taken by removing the scaling pair with all other tubes in.

This data demonstrates that the scaling stages are not critical as to voltages. The writer has found that the following voltages are of use in trouble shooting. Interstage amplifier B- should be -35 to -40 volts; plate voltage of the conducting tube should be under 100 volts. Grid of the not conducting tube should be at least -35 volts. B+ should be at least 350 volts.

The stages are not critical as to tubes and any tube that checks all right on a tube tester should be satisfactory. 6C5, 6J5, and 6P5 tubes may be used interchangeably. However, failure of a stage to scale does not necessarily block the set. The set can scale through and the interpolate meter does not give as good indication of trouble as the neon lights used with the Columbia circuit. The triode scale of 64 (717-B-11) uses neon lights for that reason and because an interpolate meter cannot be used with a scale of 64.

Line voltage stability of the sets is good but the interpolate meters do not read correctly when the line voltage is different from that at which the calibration potentiometers were set. The only set that has been thoroughly investigated by the writer for surge stability is the triode 64 (717-B-11) which is stable from 90 to 135 line voltage on surges. The power

supply of this set differs from that shown in the drawing in that two rectifier windings and two rectifiers were used to get the plus and minus voltages.

F. OUTPUT STAGE

The output stage uses a 6C5 inverter amplifier and an 884 thyatron to drive the Cyclotron round case recorder. No trouble has been encountered with this circuit to date. I should be noted, however, that this output stage will not drive a Wizard Counter.

G. HIGH VOLTAGE SUPPLY (717-B-12 and 13)

The high voltage supply uses a single 47 tube to regulate it. It is rather complicated to stabilize two knobs on the front of the set and a test switch to throw resistance into the supply to the high voltage transformer being manipulated to give good voltage stabilization. Practically no load can be drawn from the supply, the load of a G-M tube and Neher-Harper circuit counting at a rate of 2000 counts/min. being enough to cause a distinct drop in voltage. In addition, the Pyranol output condenser is very critical in alpha service, condensers good for all normal purposes allowing enough A. C. ripple to pass through to upset the alpha amplifier.

Maintenance on this part of the circuits has consisted of replacing defective dropping resistors in one G-M set and two Pyranol condensers in alpha sets.

One G-M set has been rebuilt to use the high voltage circuit shown in drawing 717-B-16. This high voltage was stable at 1000 V. output from 80 to 135 volts on the variac with no load, no meter deflection being perceptible. It was stable in the same way at 1000 volts when one milliampere was drawn from it at regular line voltage. No hash was introduced in the alpha sets by this high voltage and the beta set containing it is now in regular operation in 205 counting room. No drift has been encountered in the high voltage of this set after the initial warm up.

H. TRIODE SCALE OF 64 (Dwg. 717-B-11)

A triode scale of 64 was built according to the drawing 717-B-11 except that two rectifier windings and rectifiers were used for the plus and minus voltage supply. When first built, sufficient ventilation was not provided and trouble was experienced with change in the 400,000 ohm dropping resistors. This trouble has been cured by drilling ventilation holes in the top of the chassis. The set was put into operation December 17, 1943 in the 105 Bldg. counting room. No troubles within the set were encountered until January 7, 1944, at which time the last two stages stopped scaling and the set started to blow fuses. This was traced to the 6L6G which had 2 megohms between the grid and ground on fixed bias. The dropping resistor network was changed and the set put back into service with nothing whatever being done to the scaling stages.

Original tune-up of this set demonstrated the necessity for having the -75 supply adjustable so that the highest conducting plate was below 100 volts. Outside of that, no unexpected factors were encountered.

I. TRIODE SCALE OF 64 - GENERAL REMARKS

The set B+ must supply at least 80 milliamperes and the B- should supply 15 ma. The use of 6SN7 tubes instead of 6C5's for the scaling pair would reduce the number of scaling tubes required from 18 to 12 and make the layout comparable to that of a Columbia Type Scaler. The B supply circuit shown in the drawing provides a circuit that requires only one rectifier and rectifier winding but requires a VR 90 to prevent the recorder current from upsetting the B minus.

If sets like this were manufactured in large quantities, it would be advisable to use 10% 400,000 ohm resistors plus perhaps 10% 100,000 ohm resistors. Aside from that no special precautions need be taken. Use of a bus bar for B+ and B- voltages is advantageous from a maintenance viewpoint in that a poor joint to one stage will not affect the operation of other stages.

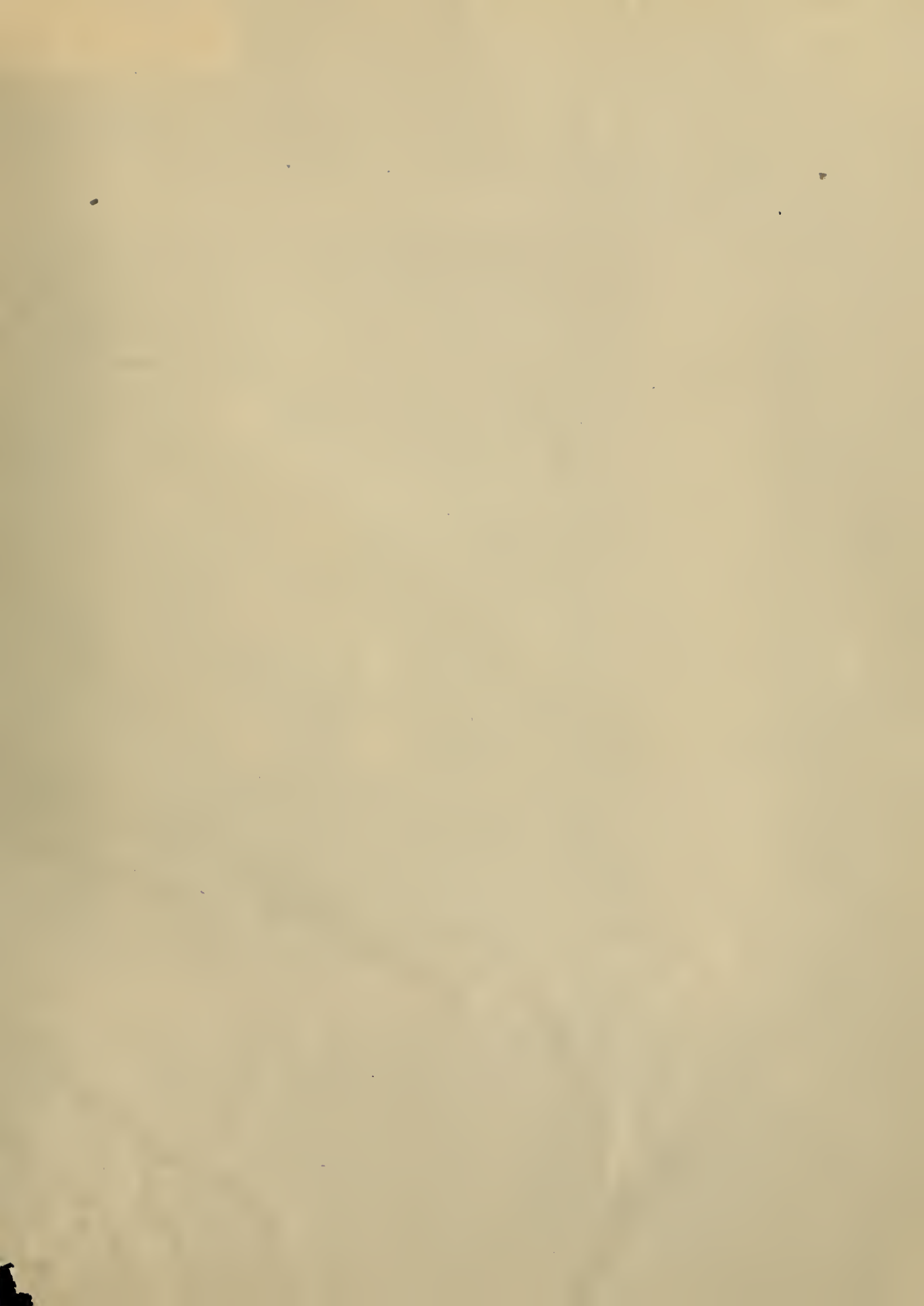
Voltage data on the existing scale of 64 is as follows: B+ 410 volts; B- to scaling pair -75 volts; B- to amplifiers -35 volts. The grids range from $5\frac{1}{2}$ to 29 volts with tubes of that pair out, and the maximum grid to grid difference is $13\frac{1}{2}$ volts.

PERFORMANCE OF COUNTER G-9

Plateau Runs

VOLTAGE	COUNTS/MIN.	COUNTS/MIN.
	RESISTANCE QUENCHING	NEHER-HARPER QUENCHING
900		Threshold 1928
920	THRESHOLD	
950		2112
960	2880	
1000	2816	2108
1040	2944	
1050		2148
1080	2944	
1100		2120
1120	3008	
1150		2124
1160	3200	
1200		2220
1250		2220
1300		2244
1350		2216
1400		2292
1450		2544
1500		2812

The lengthening of plateau by means of Neher-Harper quenching is apparent.



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